A COMPARISON OF FOUR METHODS OF SCALING.

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CONTENTS

Chapter.	Particulars.	Pages.
I.	Introduction.	1-16
II.	Tool Construction.	17-29
III.	Administration and Data Collection.	-30-39
IV.	Procedures for Analysis,	40-50
V.	Presentation of data and Interpretation.	51-69
VI.	Discussions: Conclusions.	70-73
	Limitations.	
	Bibliography.	[illegible]-74-
	Appendices. A1 to A36	76 -

LIST OF TABLES.

Table No.	Particulars.	Page.
1.	Scale values based on Independent group of 15.	53
2.	Scalevalues based on the Same Set of 60 subjects.	55
3.	Ranks, based on Independent Groups of 15.	56
4.	Ranks based on the same set of 60 judges.	57
5.	Inter-rater consistency.	59
6.	Inter Correlations based on Independent groups of 15 each.	61
7.	Inter Correlation of Scale-values based on judgements of 60 judges.	62
8.	Inter Correlations between ranks based on independent groups of 15 each.	63
9.	Inter Correlations of rank orders based on judgements of same set of 60 students.	64
10.	Time taken by students in first administration forms (in minutes) for 4 groups of 15 each.	65
11.	Analysis of Variance. (Simple random design)	66
12.	Average time taken by 60 judges in Completing different forms.	66
13.	Analysis of Variance table (Cross over design)	67
14.	Coefficient of Agreement.	69

CHAPTER I.

INTRODUCTION.

The method of paired comparison is a well known technique of psychological and psychophysical scaling of stimuli. The range of applicability of this method is extended to ranking and scaling of affective values, and of aesthetic values; visual, auditory and taste stimuli; statements representing varying shades of opinions on questions of social importance such as prohibition, war, religion etc. It might replace the less accurate and less valid procedures of rating scales, where the more exact and accurate procedures of scaling are needed. The method of paired comparisons is a direct method for obtaining empirical estimates of the proportion of times any stimulus i is judged greater or better than any other stimulus j. So this method might very well provide a criterion of validity against which to check any of the less accurate or less dependable methods of scaling stimuli, persons, things, attributes or opinions.

However, there is one objection often raised against the method of paired comparisons. When the number of stimuli is 15 or more than 15, the number of pairs will be 105 or more, the method of paired comparisons becomes cumbersome and other extraneous factors, such as fatigue, boredom etc, enter into the process. These extraneous factors restrict the applicability of the method of paired comparisons. The paired comparisons is one of the best methods of scaling, but this method is generally recommended only when the number of stimuli is 15 or less.

Several short cut procedures as use of partial pairs or triads are suggested for the case when the stimuli are large in number, so that the labour involved in making comparisions is reduced. In ~~two~~ this study, the main objective is to compare the methods using (a) Partial pairs (b) triads and (c) quadruplets with the method of paired comparison in which the complete set of pairs is used. The purpose is to know as to what extent these four methods give the same results.

REVIEW OF RELATED LITERATURE

Complete Pairs:

Thurstone (1927, a & b) published two

research papers, in which he developed the law of comparative judgement. It assumes that for a given stimulus i there is associated a most frequently aroused modal discrimination process on a psychological continuum. He defines the discriminal process as, " That process by which the organism identifies, distinguishes or reacts to stimuli", so discriminal process changes from time to time due to momentary fluctuations in organism. He further assumes that the distribution of all discriminal processes aroused by stimulus i is normal about the modal discrimination process. This distribution has modal discrimination $\bar{S}_i$ as mean or mode and discriminal dispersion σ_i . Suppose there is another stimulus j, which is also to be judged with respect to the same attribute as stimulus i has been judged. Suppose it has $\bar{S}_j$ as the modal discrimination process and σ_j as discriminal dispersion.

Since the discriminal processes of the stimuli i and j are assumed to be normally distributed the difference of these variables are also normally distributed with σ_{i-j} as discriminal dispersion

$$\text{where } \sigma_{i-j} = \sqrt{\sigma_i^2 + \sigma_j^2 - 2 r_{ij} \sigma_i \sigma_j}$$

is the standard deviation of the difference

$S_i - S_j$,

σ_i = the standard deviation of the discriminal processes, S_i

σ_j = the standard deviation of the discriminal processes S_j

r_{ij} = the correlation between S_i and S_j

The scale separation between stimuli i and j is expressed by Thurstone as

$$\bar{S}_i - \bar{S}_j = z_{ij}\sqrt{\sigma_i^2 + \sigma_j^2 - 2 r_{ij}\sigma_i\sigma_j}$$

Where $\bar{S}_i$ and $\bar{S}_j$ are modal discrimination processes of stimuli i and j. The value of normal deviate Z_{ij} corresponds to the proportion of comparative judgements p_{ij}, that is, the proportion of times i is judged better (or greater) than j. With further assumptions that $\sigma_i = \sigma_j$ for all i and j and equality of inter-correlations ($r_{ij} = r$) we find

$$Z_{ij} = \bar{S}_i - \bar{S}_j / \sqrt{2\sigma^2(1-r^2)}$$

Further we may assume a common unit of measurement in such a way that

$$Z_{ij} = \bar{S}_i - \bar{S}_j$$

From this it follows that the mean scale value for the ith stimulus may be represented by

$$\bar{Z}_{i.} = \frac{1}{n}\sum_{j=1}^{n} Z_{ij} = \bar{S}_i - \bar{S}$$

where $\bar{S} = \frac{1}{n}\sum \bar{S}_i$

This formula is helpful in determining the scale values of the stimuli from the knowledge of the p_{ij}'s.

The number of complete pairs of n stimuli is given by $\frac{n(n-1)}{2}$. If there are 15 stimuli, then the corresponding number of complete pairs is $\frac{15 \times 14}{2} = 105$. In the complete pairs, if there are n stimuli then each stimulus occurs once with n-1 other stimuli in the group. It means, that every stimulus in the group has got equal opportunity to occur with all remaining stimuli.

Ross R.T.(1934) has given a scheme of presentation of these complete pairs to the judges. He gives 'Optimal' orders of presentation of pairs for the number of stimuli from five to seventeen as well as a general method for calculating 'optimal' orders of presentation.

His orders are 'optimal' in the sense that

(i) Each stimulus appears first in half the pairs of which it is a member.

(ii) Pairs having one stimulus in common are maximally separated in the orders of presentation.

(iii) There is no detectable pattern of correct responses.

PARTIAL PAIRS

As in the complete pairs, if there are n stimuli, each stimulus occurs with all ; n-1 stimuli of the group. This is not the case with partial pairs. In the partial pairs, each stimulus is not paired with all the other stimuli of the group, but only with a few of others. However the number of times any stimulus occurs with other stimuli is fixed. Total number of partial pairs is given by $\frac{n \times a}{2}$, where n is the total number of stimuli and a is the number of times each stimulus occurs with others. Partial pairs are balanced in the sense that each stimulus gets equally represented in the set.

Kephart and Oliver (1952) gave the idea of sets for formation of partial pairs. A set contains minimum number of pairs, which would permit each member of the group to occur with others equal number of times. Total number of sets in complete pairing is given by $\frac{n-1}{2}$, where n is the number of total stimuli in the group. Hence a set is balanced group of minimum number of pairs. If the number of stimuli is odd, then each set would consist of n pairs and in every set, each stimulus occurs with two others. For example if n = 5, then there will be 2 sets

Set 1	Set 2
1,2	1,3
2,3	2,4
3,4	3,5
4,5	4,1
5,1	5,2

If there is an even number of stimuli, then the last set will dontain only $\frac{n}{2}$ pairs. Thus for n 4, there will be one complete set and the other set will contain only half the number of pairs. In every complete set each stimulus gets represented twice, while in a half set, every member is represented once only. For n 4, we shall have :

Set 1	Set 1/2
1,2	1,3
2,3	2,4
3,4	
4,1	

The idea of sets, gave the idea of reducing number of pairs and still maintaining the balance of equal representation of each stimulus. The reduction in the number of pairs in this way leads to the partial pairs technique.

A REVIEW OF STUDIES IN WHICH INFORMATION FROM PARTIAL PAIRS, IS EXTRACTED AND COMPARED WITH THAT FROM COMPLETE PAIRS.

Mc Cormick and Bachus (1952) and Mc Cormick and Roberts in two closely related papers, formed various schedules of partial pairs extracting various balanced sets systematically from the original set of complete pairs. Originally they took 50 persons, employed in a factory as stimuli, which were to be judged for their efficiencies in the work by their supervisors, so the rating task was assigned to the former, under whom these 50 persons already worked. 1225 pairs of 50 persons were presented to those judges. From this, information for various sets of partial pairs, were collected and correlations of the partial pairing scale values with scale values obtained by complete pairs were calculated. They found that in place of complete pairs, partial pairs were almost equally effective.

Mc Cormick and Bachus (1952) also gave a systematic method for getting partial pairings in which selection of pairs is random. All stimuli are randomly assigned to positions along the borders of the judgement matrix and then selecting sets of matrix diagonals, so that all stimuli enter into the same number of comparisons. They took a group of 30 stimuli and formed four schedules of partial pairings by the same method as follows :

24:29 16:29 12:29 & 8:29

Here a:b partial paring means that a stimulus is paired with a out of b other stimuli while the total group consists of b 1 stimuli. This notation of partial pairing is used by previous workers in the field. They found that the correlations of scale values obtained by various schedules of partial pairing with those obtained by complete pairings are almost directly proportional to the number of sets from original complete pair sets, they used in the partial pairings.

Oliver (1953) conducted an experiment to find out correlations between partial pairing and complete pairings after controlling rater un-reliability experimentally. He found correlations ranging from .845 for 8:49 pairings to .996 for 24:98 pairings. Average correlations for 14:29 pairings varied from .96 to .98. Reliabilities of 14:29 pairings among these partial pairings that were equally abbreviated and mutually exclusive ranged from .825 to .936.

Mc Cracken (1958) used 25 job classifications as stimuli. He formed partial pairs randomly selecting one set out of original 12 sets of 25 stimuli. He presented 12 sets to the raters. He obtained a correlation of .93 between scalevalues obtained by

randomly selected set of partial pairs and complete pairs. In all the above studies, the data utilized were extracted from complete pairing matrices.

EMPIRICAL APPROACH TO PARTIAL PAIRINGS.

Rambo (1959) empirically compared the complete pairing of 30 stimuli and five partial pairing schedules. He used for stimuli 30 nationality group names, which have been extracted from the Borgardus scale of social distance (1947). He used independent groups of 10 independent raters for each of the six rating schemes.

Complete and partial pairing tasks assigned to six experimental groups :

Group	Number of pairs per stimulus	Total number of pairs
Z	29	435
A	25	375
B	20	300
C	15	225
D	10	150
E	5	75

He found following correlations between the scale values obtained by partial pairing and those of complete pairing.

Group	r
A	.93
B	.91
C	.93
D	.82
E	.77

He found that with upto the 80% reduction in the number of pairs, partial pairings resulted led to high correlations of order .93 with scale values obtained from complete pairing. He remarked that in previous studies correlations were found to be comparatively high but it was due to the fact that the data extracted from complete pairings were utilized.

Allan R. Starry, also empirically compared partial pairing and complete pairing methods. His study will be discussed later in this chapter.

TRIADS

A triad consists of three stimuli. Schucker (1959) remarked that it is readily apparent that the partial pairing technique does not fulfil the requirements for balance with respect to the estimation of

stimuli scale-values. He suggested that balanced triads presentation would help the situation, where large numbers of stimuli are to be scaled with equal accuracy.

In this presentation, n balanced triads serve the purpose, when corresponding complete pairs are 3n in number. Work of the judges becomes 2/3 of original, which they are expected to exert in rating of complete pairs of corresponding stimuli.

W.W.R.Ball obtained triads by cyclic enumeration of configuration. He gives solution triads for N 9, 15, 21, 27, 33, 39, 45, 51, 57, 63, 69, 75, 81, 87, 93 and 99. The number of triads for a group of n stimuli is given by the formula $\frac{n(n-1)}{6}$. Ball has given the solution triads only for n's which are odd multiples of three, and are $<$ 100.

COMPARISON OF THREE METHODS OF SCALING:

Allan R. Starry (1967) compared these three methods of scaling i.e. complete pairs, partial pairing and triads. He selected, developed and utilized a study of apparent size conducted by Crambart (1959). The raters were 20 volunteers of psychology department of Purdue University. Randomly six groups were formed of

15 each. Complete pairs and partial pairs 6:14 were formed as suggested by Kepphart and Oliver (1952) and Oliver(1953). For triads the method used was of Ball as suggested by Schuper. The whole rating work was done in six sessions of 30-50 minutes. For each form, two independent groups rated independently in two sessions. Results of his study are noted below.

The underlined figures are obtained after applying correction for attenuation.

CORRELATION BETWEEN SCALE VALUES OBTAINED
THE DIFFERENT METHODS OF SCALING

Method	Partial	Triads	-Grambert's original pairing.
Complete pairing	.89	.85	.90
	.97	.91	
Partial	——	.91	.85
		.97	
Triads	——	——	.89

For each method he obtained test-retest reliability that ranges between .95 and .97. His study shows that the use of partial pairing and triads are

almost equally effective. In his experiment Ball's method was used to form sets of balanced triads of stimuli. The method is applicable only when the number of stimuli n is odd multiple of 3 . Cox (1940) extended the principle of cyclic enumeration of configuration in his paper on "Enumeration and Construction of balanced in complete block configurations". By his method, balanced triads can be obtained for all such n for which n(n-1)/6 is an integer.

QUADRUPLETS

Though there does not seem to be any study on the use of Quadruplets for scaling, here the investigator made use of a balanced set of quadruplets also for scaling. The idea was to try a simple extension of the triads technique. The designs of the balanced quadruplets are provided by Cohran and Cox in their discussion of balanced incomplete blocks design. In the Quadruplets method, 4 stimuli are presented at a time to the judge. The effective-ness of the quadruplet method will be compared with that of the other methods.

In this study, it is proposed to compare empirically the following four procedures:

(a) Complete pairing

(b) Partial pairing

(c) Triads

(d) Quadruplets.

For that a set of 13 activities is selected from the leisure time activities of young boys. A suitable design was used that made it possible to compare the four methods.

(a) as used on four different groups of boys

(b) as used on the same set of boys, but with the counterbalancing of order effects.

Here the research hypothesis is that the methods using partial pairing, triads and quadruplets would involve less time compared to complete pairing and would give more or less same rankings and scale-values for the 13 stimuli. The investigator has selected the 13 stimuli which are achivities to be ranked in order of preference by the students. Thus there may be a large disagreement among students in the matter of preference. The investigator will see how the different techniques compare in such a situation.

The results of this study will throw light on the applicability of short cut procedures in the

place of complete pairs, the use of which is generally limited to the case where the number of stimuli is not large.

* * *

CHAPTER II.

In this study the four methods of scaling (complete pairs, partial pairs, triads and quadruplets) will be compared empirically. Unlike some other studies in the past, where the comparisons were made in respect of visual or other stimuli to be scaled on a psycho-physical continuum, here the investigator decided to compare the four methods of scaling in respect of the preferences shown by students to certain leisure time activities. In such a situation there may not be a high degree of agreement among judges (i.e. students). The study will help us in showing the relative differences of the different methods in such a situation.

Apart from the main objective of comparing the different methods of scaling, there was some interest in knowing what leisure time activities are prefered by the students of the XI Class. The activities, in which they indulge in their leisure time at this stage, have some impact or their later development. The

administrators should not neglect this aspect of education. The method of paired comparisons and other methods here are likely to give fairly accurate scale values for the various activities preferred by the students.

CHOICE OF ACTIVITIES

For the purpose of this study, we define leisure time as the time students get in the after noons after finishing their college hours and doing home assignments. Those activities are taken into consideration, in which students usually indulge for mental refreshment or recreation.

The investigator visited the students of Class XI in the class-rooms and talked with them about their activities in their leisure hours. He encouraged the students to give informations about their preferences to the activities, in which they wish to indulge in their leisures.

They were put the following questions :

(a) List all those activities, which you prefer in your leisure time.

(b) How much time do you devote for these leisure time activities.

(c) If possible, please give the hours, which you consider to be leisure hours.

There was a good response. From these the list of activities was prepared. According to their preferences the activities were listed in serial order. Most of them indicated that they devote at least one and half hour in the evening ranging from 6 P.M. to 8 P.M. Total number of activities were 27 in the list.

The design of experiment was such that every judge (student) had to respond to four forms of the opinionaires (i.e. complete pairs, partial pairs, triads, and quadruplets). It was not possible to select a large number of stimuli for this particular experiment, because of certain practical difficulties in administration of the opinionnaires. It was decided to select 13 stimuli. As this is not odd multiple of 3. Ball's procedure of forming a balanced set of triads could not be used. However, from the balanced incomplete block confegurations presented by Cohran and Cox in their book on 'Experimental design', it was possible to get a balanced set of triads for this case of n 13.

Out of the previously prepared list of 27 activities, 13 activities have been selected, which were the more preferred than others. These were presented in Hindi and are given in Appendix A-1.

Translated into English these are :

1. Seeing a film.
2. Singing or playing a musical instrument.
3. Gossipping with friends.
4. Walking in open air.
5. Seeing a match of cricket, hockey etc.
6. Reading magazines.
7. Reading news-paper.
8. Reading novels.
9. Listening to radio.
10. Chit-Chatting with family members.
11. Relaxing in a quiet place.
12. Playing out door games.
13. Playing in-door games (cards, carrom etc.)

For preparing the scheme of presentation, the investigator uses the number of stimuli as given in the above mentioned list. Four forms of opinionnaires are to be prepared corresponding to the four methods of scaling. These are described below :

(1) Complete pair form. The total number of complete pairs corresponding to 13 activities in 78. Ross (1934) has given a scheme of presentation of these pairs in an 'Optimal' orders of which a mention has been made in Chapter I. All the pairs of the 13 stimuli were arranged according to the scheme suggested by Ross. In the appendix (A-2) specimen copy of the plan

is given and in appendix A-3, final form of complete pairs presentation is given.

INSTRUCTIONS.

Instructions to judges (i.e. students) were given in Hindi. A speciman copy of the instructions in Hindi, which were given to judges with complete pairing form is attached in Appendix A-3. The students always feel afraid of giving in correct answers in an examinationsituation. For removing this fear, they were told that it is not the examination and only their preferences were to be expressed for certain activities and there is no wrong or right answer. Also they were told that they should not take undue time in expressing their preferences. The actual instructions were, " Dear students, After finishing school work, every student indulges in some recreational activity in his leisure in the evening. With help of this opinionnaires we want to know what activities our students prefer in their leisures. This is not any type of examination, so there is no wrong or right answer. Only that answer is right, which is according to your choice.

In this opinionnaire, leisure time activities are presented in the form of pairs. First read carefully both activities of the pair. After thinking, which activity do you prefer out of these two, only

that activity should be tick marked (✓). For an example, one pair is given below.

1. (a) Writing letters.
   (b) Flying a kite.

One, who expressed this opinion, likes more activity'a'than activity'b' or he likes more (a)writing letters than (b) flying a kite.

In all pairs, according to your choice place a tick-mark (✓) on (a) activity or (b). Do not place tick mark (✓) on both or leave both unmarked. In selecting your preferences, do not go with the opinion of your class fellows, only your opinion is important for your preferences. Make haste, as you can, but there is no restriction of time. Tick-mark (✓) your choice.

PARTIAL PAIR FORM

In this form there are 39 pairs, which is half of the original complete pairs. Rambo's study indicated that partial pairs, scale values closely approximated to those obtained from a complete pairing, when the number of pairs was 50% or more of the number in complete pairing. Further reduction seemed to result in a more serious modification in scale-values obtained. But Allan R.Starry obtained

correlation .97 between scale-values with 6:14 partial pairing and complete pairing methods. Here keeping in view the results of these studies a 6:12 partial pairing has been used.

The investigator used Mc Cornick and Bachus method to form partial pairs. To use the procedure described by him, the following 13x13 matrix is used.

MATRIX FOR FORMATION OF PARTIAL PAIRS.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2	x												
3		x											
4	x		x										
5		x		x									
6			x		x								
7	x			x		x							
8	x	x			x		x						
9		x	x			x		x					
10			x	x			x		x				
11	x			x	x			x		x			
12		x			x	x			x		x		
13	x		x			x	x			x		x	

For forming the partial pairs by this scheme, stimuli are placed along borders of the judgement matrix, then select two lines parallel to diagonal, so that the total number of cells, which are crossed by these lines, is 13. The cross (X) may be marked in all these cells. The co-ordinates of these cells constitute a balanced set of pairs. Here 3 sets of complete pairs have been obtained as shown in the figure. For that six lines parallel to the diagonal had to be drawn. Here each stimulus occurs with others six times only, so the total number of pairs is $\frac{n \times s}{2}$ $\frac{13 \times 6}{2}$ 39 in this scheme, and it may be referred to as 6:12 partial pairing scheme.

In the Appendix A-4, the scheme of partial pair arrangement is given. The investigator tried to keep maximal separation of common stimuli pairs and equal representation of these in the first place and second place in a pair to get an optimal order in presentation of these as Ross has suggested.

Finally the numbers are replaced by stimuli. In the Appendix A-5, a copy of final partial pairs form with instructions is given. Instructions are the same as written for complete pairs.

TRIADS

Here, for 13 stimuli, the numbers of balanced triads is given by the formula $\frac{n(n-1)}{6}$ $\frac{13 \times 12}{6}$ 26, so there are 26 triads, which is 1/3 of total number of complete apairs. The investigator used Cox's balanced in complete block configurations, which gives balanced triads for all those cases, in which $\frac{n(n-1)}{6}$ is an integer.

For the purpose of this study the investigator uses Plan 11.21 on page 477 of Cohran and Cox, " Experimental Design", which is reproduced in Appendix A-6. Finally the numbers are substituted by the corresponding stimuli and the final form of triads so obtained is given in the Appendix A-7. These triads are balanced, in the sense that each stimulus is represented equal number of times and the each activity is exactly paired once with w every other activity in these six sets.

INSTRUCTIONS

For this form of presentation most of the instructions are the same as for complete pairs and partial pairs. Only the instructions to express their preferences are different from those of the complete and partial pairs.

In the case of triads, the investigator instructs the judges to choose the most preferred activity first, out of the three in any given triad and tick mark (_/) the same. Next out of remaining two, choose one which is the least preferred and put the cross (X) against that activity.

For example, there one triad is :

1. X(a) Playing indoor games.
   _/(b) Seeing films.
   (c) Playing out-door games.

In this triad, suppose the judge expresses the maximum preference to seeing films, so a tick-mark (_/) is put against (b). Also he expresses the least preference to activity playing indoor games, so cross (X) is put against it. The student is asked to excercise his relative judgement only considering these three activities of a triad at a time. A copy of detailed instructions, which are given to judges, in Hindi is reproduced in the Appendix- A-7.

QUADRUPLETS FORM:

This form consists of 13 balanced quadruplets. Here a quadruplet is a group of four stimuli, which

are presented together in a single item.

The set is balanced because each stimulus occurs exactly 4 times in the whole set, and each one occurs exactly once in combination with every other stimulus. It is thus a balanced set in the same sense as the set of triads is. It may be noted that the set of Partial pairs was not balanced in this sense. There every activity occurs exactly six times, but it does not occurs once in combination with every other activity.

For the purpose of this experiment Plan 13.5 on page 523 of Cohran & Cox, 'Experimental Design' is used for forming a balanced set of Quadruplet. The plan is reporduced in the Appendix A-8. Finally the numbers are replaced by corresponding stimuli, and the form so obtained is given in the Appendix A-9 alongwith the instructions.

In the case of quadruplets also most of the instructions are the same as in the case of complete and partial pairs. Only the instructions to judges for expressing their judgements are different.

In this, the judges are asked to choose the activity they prefer most out of the four, which are presented and tick mark (✓) it. Then out of the

remaining three, they are asked to choose the activity, which is the least preferred and put across (X) against it. Next they are asked to consider the remaining two and choose the ~~ad~~ activity, which is more preferred than other and draw a circle O around it.

For example, consider a quadruplet

1. ⓐ Seeing Film.
   (b) Playing indoor games.
   X(c) Relaxing in a quiet place.
   ✓(d) Playing out-door games.

In this, suppose a judge prefers (d) as the best out of the four. A tick-mark (✓) is put against it. If the least preferred out of remaining three is (C), then across (X) is put against it. Out of remaining two he is asked to choose one, which he prefers more. If he prefers (a) more and according to the instructions he draws circle(O)around it.

The judgement of the judge is made considering these four stimuli at a time. The detailed instructions in Hindi with an illustration are given in Appendix A-2.

Before the instructions were given the students were asked to fill up following information:

1. Name,
2. Age,
3. Name of the institution,
4. Class.

TRY OUT:

These four forms were tried out on each of four students of Class XI successively. The time taken by each student was about 55 minutes for all these four methods. They followed instructions and worked accordingly. Apparently there was no confusion and they completed their task properly without leaving any pair, tried or quadruplets unmarked. After this try out the tool was ready for the purpose of the experiment.

[redacted]

CHAPTER III.

In this Chapter, the procedure for selection of sample and the design of experiment will be described.

SELECTION OF SUBJECTS:

The investigator chose 60 students of first year in the Intermediate College, Sonkh Khada, district Mathura. They were all of humanity stream. The total enrolment in the first year class was only 60. Age range of students was 14 to 20 years. The students belonged mostly to middle class agriculturist families.

FACILITIES OF ENTERTAINMENT:

Local population of the place is only about three thousand. There are only two centres, where the students could get some entertainment in this place, one being the college and the other Panchayat [illegible]

Ghar.

(1) AT COLLEGE :

College has got playing field of 8 acres. Facilities are avilable for all major out-door games i.e. Hockey, Foot-ball, Volly-ball, Cricket etc. The Physical Instructor of the College is an efficient youngman who always encourages the boys to play games and coaches them also. For indoor games, there are two or three sets of Carrom-boards, but there is no arrangement for table-tennis etc. There are two sets of Harmonium, table, Dholki, Sitar for training the boys to participate in drama. It is worth mentioning here that college has got many students who sing well and who are trained for taking part in drama and musical programmes at the district and regional level. Library facilities are satisfactory. There are 7000 books in the library. Every student is entitled to draw two books for a week. About 40% boys use the library. There is a reading room too, where the boys can sit and read any thing they like. There are adequate number of news papers and magazines available. There is also a radio set and in the recess they can hear news and music on radio. This college and the neighbouring schools co-operated well with each other. Friendly matches of Hockey, Foot-ball etc.

are often played by the students. It is a co-educational institution.

(2) PANCHAYAT GHAR:

This is the second centre of attraction. It has got radio, material for indoor games, as carrom chess, playing cards etc. A reading room is also there, which has some papers and magazines. Some musical instruments are also kept there.

DESIGN OF EXPERIMENT:

The 60 students were divided into 4 groups, at random. Each group consisting of 15 students. The design of the experiment is given below. It is a latin square arrangement with multiple measurements on the same subjects. The design is often referred to as a cross over design.

TABLE:

LAYOUT OF THE DESIGN.

Order	Group A	Group B	Group C	Group D
First	Complete Pair Form.	Partial Pair Form.	Triad Form.	Quadruplet From.
Second	Triad From.	Quadruplet Form.	Complete Form.	Partial Pair Form.
Third	Quadruplet Form.	Complete Form.	Partial Form.	Triad Form.
Fourth	Partial Pair Form.	Triad Form.	Quadruplet Form.	Complete pair Form.

To the first group, the complete pair form has been administered first, then triads, then quadruplets and finally partial pairs form is administered. Similarly for the other groups, the four forms are administered successively in the orders indicated above. The interval between 2 administrations is 3 to 5 minutes.

The following points are worth noting :

(i) Each group has four administrations corresponding the four methods of scaling. It means that every member of the group is required to take each form. Since the preference for activities would vary more from person to person for a proper comparison of the methods, it is desirable to obtain the response of each student to each form.

(ii) Every form appears in first, second, third and fourth administrations with one or the other group. Thus the complete pair form has been given to the first group in first administration, to the third group in the second administration, to the second in the third administration and finally in fourth administration it is given to the group IV. In this design, each form occurs once in each order and each group gets each form in one or the other order. Thus with this design, the order effects are counter balanced.

(iii) In this design, memory of responses of one form may affects the results of subsequent forms, but not severely, because pairs, triads and quadruplets pose different situations. However, the comparison of four groups only with respect to the results of the

first administration of the four forms will be free from any carry-over effect of memory. That has also been done using the data of the first row only in the table layout of design treating it as a simple randomised design. But in this the error term would consist of subject to subject variations and would be comparatively much larger.

THE EXPERIMENT:

The investigator fixed up with the Principal, Kisan Inter College, Sonkh Kheda, district Mathura,The time to conduct this experiment. The date and time fixed up were 13th March, 1968 at 10.30 A.M.

The list of the boys of first year class in alphabetic order was obtained and with the help of a table of random numbers, 60 boys are divided into four groups of 15 each.

In a room and varanda, 60 seats with desks were arranged. The atmosphere was placeful. The lecturers of the Institution were very helpful and co-operative. One lecturer was assigned each group, to work as an invigilator for the group. His work was to distribute forms, collect forms and note the times of distribution and collection on each form. The

see to it that there was not be any type of intercommunication among students.

The investigator then addressed the students and told them about the work, which they were going to do. They were asked to read instructions first and then proceed further. The investigator discussed some points about expressing their judgements, which were already in the instructions. Instructions were enclosed with each form. With the instructions in each form, an example was there for illustration. They were told that instructions were self contained and they should not talk with follow students. If there was any difficulty, they could read the instructions again and even then if difficulty remained, they could ask the invigilator of the group. They were asked not to spend much time in expressing their judgements and also they should not leave any pair, triads or quadruplets unmarked.

OBSERVATIONS DURING EXPERIMENT:

At 10.40 the forms were distributed. As soon as these were distributed, the students got busy in answering it. After 3 or 4 minutes, students started to get up and to give back completed forms. Some difficulty was faced by the invigilators of the groups

in collecting, checking and noting the time. But the situation was handled efficiently, when the investigator and the Principal, who were supervising the work, began to collect, check and note the time of submitting. Thus a team of six persons were engaged in this task, with proper supervision there was not much ~~kim~~ inter-communication between students. Maximum efforts were made to avoid contamination of results due to intermixing of boys at the time of testing. The whole experiment lasted about 45 minutes. The students except one student, found no difficulty in reading the instructions and expressing their preferences. The one student, who did not seem to know, which activities in a pair he preferred, was asked to read the instructions again after reading instructions he was able to express his prefernde for one of the activities.

CHAPTER IV.

In this Chapter, certain statistical procedures for finding out scalevalues, within rater reliability etc are discussed.

PRINCIPLE OF COMPARATIVE JUDGEMENT USED IN FINDING OUT SCALE-VALUES.

As has been mentioned in Chapter I, Thurstone assumed that with a given stimulus i is associated most frequently aroused modal discrimination or a psychological continum with reference to some attribute. He assumed that discriminal processes are normally distributed about mean or modal discriminal process $\bar{S}_i$ with a standard deviation or discriminal dispersion Suppose there is another stimulus j, which is judged with respect to the some attribute, has mean $\bar{S}_j$ and Standard deviation

Then, it $\bar{S}_i > \bar{S}_j$, it means that more than 50% of subjects say that i is more favourable than j. If S_s $\bar{S}_i = \bar{S}_j$, it means that 50% subjects prefer i

to j and the other 50% of the subjects prefer j to i.

Let f_{ij} is the number of subjects, who prefer i to j. If N is the total number of subjects then $p_{ij} = \frac{f_{ij}}{N}$ is the proportion of subjects prefering i to j.

Let z_{ij} be the value of the standard normal deviate such that the area to its left is p_{ij}.

It has been pointed out earlier, that under the assumptions that

$$\sigma_1 = \sigma_2 = \cdots\cdots = \sigma_n = \sigma$$

and

$$r_{12} = r_{13} = \qquad = r_{n-1,n} = r$$

and

A measure of scale separation of the stimuli i and j is obtained as

$$z_{ij} = \bar{z}_i - \bar{z}_j \text{ , where } \sqrt{2\sigma^2(1-r)}$$

is taken as a common unit of measurement for details, one can refer to Chapter 2 of 'Techniques of Attitude Scale Construction' by A.L.A Edwards.

DETERMINATION OF THE F-MATRIX.

The first step in determination of scalevalues consists of writing down the F-matrix that is, the matrix of $\frac{n(n-1)}{2}$ frequencies f_{ij}. In this study, there

are n 13 stimuli, so we obtain a 13 x 13 F - matrix. The element f_{ij}, that occurs in the ith row and jth column of the matrix denotes the number of times the stimulus i is prefered over the stimulus j. It will be obvious that $f_{ij}+f_{ji}=N$ and f_{ij} gives the total number of times i is preferred over other stimuli in all the nN comparisons.

SCORING OF COMPLETE PAIR FORM AND PARTIAL PAIR FORM.

In the complete pair form, there are 78 pairs and in partial pair form, there are 39 pairs of activities. Each judge (i.e. student) is asked to tick-mark (✓) the activitiy he prefers more in a given pair.

For example, one of the pair is

3.✓(a) Seeing a film (Activity No.1)

(b) Reading magazines (Activity No. 6)

In the cell (1,6) corresponding to the 1st row and 6th column, a ~~total~~ tally is put. If the student prefers the first over the second, and if he prefers the second over the first, a tally would be put in the cell (,6,1) corresponding to the 6th row and the first column. The total of all the tallies in the cell (1,6) gives $f_{1,6}$ and similarly for every other cell the frequencies f_{ij} are obtained. If

8 out of 15 students prefer 1 to 6 and the rest 6 to 1, then f1, 6 8 and f6,1 7. For convenience, keys were used with holes punched on (a) or (b) whichever corresponded to the activity with lower serial number to obtain the tallies in the upper triangular half of the f-matrix.

8 SCORING OF TRIAD FORM.

There are 26 triads in the form. In the triad form, the judge tick marks (✓) the activity, which is the most preferred in the group of three and places a cross (X) against the activity which is the least preferred of three.

For example, suppose one of the triads is marked by a student :

(a) Listening to radio (activity No.9)
✓(b) Reading novels (activity No. 8)
X (c) Seeing a film (activity No. 1)

Here since (b) is preferred both over (a) and (c), one tally should be marked in each of the cells (8,1) and (8,9) that is the cells corresponding to the 8th row and Ist column and 8th row and 9th column. Further since the activity (c) is the least preferred of the three activities, it means that (a) is more preferred than (c) and so a tally should be put in

the cell (9,1) also that is, the cell which corresponds to the 9th row and the Ist column. Thus in all 3 tallies are marked corresponding to each triad. Here also a key with holes in appropriate places was used for convenience.

SCORING OF THE QUADRUPLETS.

There are 13 quadruplets in the set. Here the judge takes three decisions corresponding a given quadruplet. He (i) tick-marks (✓) that activity, which is the most preferred of the four activities presented in the quadruplet.

(ii) marks a cross (X) against that activity, which is the least preferred of the four, and

(iii) draws a circle(O) round the activity which he prefers more out of the remaining two.

For example suppose one of the quadruplets is marked as follows by a student :

(a) Waling in open air (Activity No. 4)
✓(b) Playing out-door games (Activity No.12)
X(c) Listening to radio (Activity No.9)
(d) Reading magazines (Activity No.6)

In this Quadruplet since (b) is the most preferred of all the four. One tally should be marked

in each of the cells (12,4) (12,9) and (12,6). Here the cell (12,4) means the cell corresponding to the 12th row and 9th column and so on. Next since there is circle (O) mark on (a) it means the activity number 4 is preferred over the activities 6 and 9. Hence one tally is marked in each of the cells (4, 9) and (4,6), Finally since there is a cross (X) against (c), it means that (d) i.e. the activity 6 is more preferred than (c) i.e. activity 9 and so a tally is put in the cell (6,9) which corresponds to the 6th row and 9th column. Thus for each quadruplet, six tallies are obtained for a given student. Here again a key with holes in appropriate places was used for the sake of convenience.

DETERMINATION OF SCALEVALUES FROM F - MATRIX (COMPLETE PAIR FORM)

From the F-matrix (given in the Appendix A-10), first the P-matrix is obtained by dividing each f_{ij} by N the total number of subjects. In the table (given in Appendix A-26) P-matrix is corresponding to the whole group of 60. From the P-matrix, the Z-matrix (given in the Appendix A-30) is obtained, using the normal probability tables.

Now since $Z_{ij} = \bar{S}_i - \bar{S}_j$

We can write $\sum_{1}^{13} z_{ij} = 13\,\bar{S}_i - \sum_{1}^{13} \bar{S}_j$

or $\frac{1}{13} \sum_{1}^{13} z_{ij} = \bar{S}_i - \frac{\sum_{1}^{13} \bar{S}_j}{13}$

or $\bar{z}_i = \bar{S}_i - \bar{S}$

Where $\bar{S}$ is the average of the scalevalues of stimulus number one in terms of its deviation from the mean of the scale values of all the stimuli. Similarly scalevalues of other stimuli are obtained.

TRIAD FORM.

In one triad as many comparisons are made as in 3 pairs. There are 26 triads, so corresponding to 26 triads, there will be 26x3 78 pairs judgements. Counting the tallies in each cell, the F-matrix (given in Appendix A-19) is obtained, and dividing the each cell frequency by the total number of judges the P-matrix (given in the Appendix A-28) is obtained. Finally with the help of normal probability lables Z-matrix (given in the Appendix A-32) is obtained and from that, the scale values for the 13 activities are calculated just in the same way as z for paired comparison method.

QUADRUPLETS FORM:

In the case of quadruplets in each quadruplet as many comparisons are made as with six pairs, so that a quadruplet becomes equivalent to six pairs. In the present case there are 13 quadruplets and corresponding to them there are 13x6 78 pairs judgements. Dividing each cell frequency of the F-matrix (given in the Appendix A-13) by the total number of judges the P-matrix (given in the Appendix A-29) is obtained. The P-matrix is then converted into Z-matrix (given in the Appendix A-33) and from that the scalevalues are obtained for the 13 activities in the same way as in the case of complete pairs.

SCALE VALUES FOR PARTIAL PAIRS:

There are only 39 pairs, so half of the total cells of the F-matrix (given in the Appendix A-11) are vacant, because one stimulus occurs with only six other stimuli, not all. So six cells in a row are filled and rest of the cells are vacant. The F-matrix is converted into P-matrix (given in the Appendix A-27) by dividing the frequencies total number of judges. Next Z-matrix (given in the Appendix A-31) may be obtained from the P-matrix with the help of normal probability lable. The sum of all z-scores of a row

is divided by total number of times this row stimulus occurs with other stimuli. In this case, this number is 6. This will give the scalevalue for the row stimulus and similarly scalevalues for all other stimuli are found out.

In calculation of scalevalues with partial pairs, one point may be observed here. In the case of complete pairs

$$\bar{Z}_i = \bar{S}_i - \bar{S}$$

where $\bar{S}$ is the arithmetic mean of scalevalues of all the stimuli.

In the case of partial pairs, the mean of 2 scores of the 6 cells of ith row has been taken so that

$$\bar{Z}_i = \bar{S}_i - \bar{S}'_{(i)}$$

where $\bar{S}'(i)$ in the arithmetic mean of the scalevalues of the 6 stimuli, with which ith stimulus occurs. Here an approximation is involved. We may consider $\bar{S}'_{(i)}$ to be approximately equal to $\bar{S}$ as the former mean is based on a sample of 6 out of 12 stimuli.

An approximate procedure to be used when the number of judges is small. The procedures described above were followed for the use of total sample of 60 students for each method. While dealing with the

data of only the 1st administration, where we have data from only 15 students only for each method (given in Appendix A-22 to A-25). The Z-matrix was not obtained from the P-Matrix. In stead of that the row totals of frequencies was obtained from the F-Matrix and these were divided by the maximum sum of frequencies possible in all the cells of a row. F-matrix (given in the Appendix A-22 to A-25) are to be used for calculation of scalevalues.

In the case of complete pairs, triads and Quadruplets, this maximum number is 180 and in the case of partial pairs this is 90. Thus for each stimulus proportions were obtained. These proportions were then converted into Z-scores, giving the scale-values of the corresponding stimuli. This method of finding out scale values is suitable, when number of judges is small. It provides a good approximation for the scale-values of the previous method. In this method the F-matrix is not converted into P-Matrix and Z-matrix. It can be shown that the ratio of the difference of scalevalues obtained by these two methods is constant. Thus if y_1, y_2 .... y_{13} are scale-values obtained by the first method and x_1, x_2 .....x_{13} are the scalevalues obtained by the second method, then it may be shown that :

$$\frac{y_1 - y_2}{x_1 - x_2} = \frac{y_2 - y_3}{x_2 - x_3} = \quad \ldots \quad \text{Constant}$$

INTER RATER RELIABILITY:

It was not possible to administer the same form of the questionnaire again to the same in order to determine the test - retest reliability. To get an idea of consistency the split half reliability was calculated by dividing the students into two equivalent groups. One person was omitted at random from each group of 15 and the remaining 14 were divided at random into two groups of 7 each. Thus for the complete pairs method it was possible to form two group A and B of 28 each as follows :-

	Group A	Group B
Ist Group	7	7
IInd Group	7	7
IIIrd Group	7	7
IVth Group	7	7
	28	28

Thus for each method, two groups of 28 members have been formed. After preparing F-matrix (given in Appendix A-14 to A-21) for each of these

two groups separately. Then frequencies in each row were totalled. Product moment correlation between the total row frequencies of these two groups were obtained for each method. Then by applying Spearman Brown prophecy formula, the correlations for the whole group of 56 were also estimated.

CHAPTER V.

In this Chapter, the statistical analysis of data is presented and the main results of analysis are presented in tabular form.

As has been explained earlier, 60students were divided at random in four groups and in the first instance the four methods of scaling were administered to these four groups. Thus for each form there were 15 respondents and the four groups consisted of different students. This was like a simple randomised design. The scalevalues for the 13 activities obtained from these data are presented in table 1 and the analysis of variance for the time data in table 11.

Further to each of these four groups the other three forms were also administered in a latin square pattern to counter balance the order effects. Thus the data corresponding to the 4 methods were obtained from each of the 60 subjects. The scale values obtained for the 13 activities from the whole set of 60 students in this way, are presented in table 2, and the analysis of variance for the time data in table 11.

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Other tables give correlations between ranks of the stimuli determined by the four methods, split half reliability for each method and other comparison on time data.

SCALE-VALUES AND RANKS:

First the data for the 4 independent groups consisting of 15 students each were analysed. The scale-values corresponding to each method were obtained by the procedure described in Chapter 4. To calculate the scale values reported in table 1, the Z-Matrix were not obtained, but from the P-Matrix directly the proportions for each stimulus (i.e. activity) were calculated and transformed into Z.

TABLE 1.

Scalevalues based on independent groups of

15 students only.

S. No.	Complete Pairs, (Group A)	Partial Pairs, (Group B)	Triads Group C.	Quadruplets Group D
1.	-.285	-.729	-.622	-.882
2.	.556	.083	-.154	-.385
3.	-.820	-.765	-.882	-.656
4.	.298	.923	.656	.445
5.	-.141	.169	.141	.432
6.	-.070	-.083	.197	.210
7.	.282	.493	.385	.607
8.	.043	.283	.210	.225
9.	.282	.225	.476	.269
10.	-.043	.028	-.028	-.098
11.	-.327	-.765	-.282	.298
12.	.789	.686	.904	.493
13.	-.575	-.524	-1.190	-1.317

Scalevalues, obtained by each of the four scaling methods applied to the same set of 60 subjects are reported in table 2. As described earlier, the four methods were so adminstered that the order effects were counter balanced. In this case the cell frequencies of F-matrix were first converted into proportions and then into Z-scores. Finally scalevalues were obtained by averaging the Z-scores.

TABLE 2.

Scale-values, based on the same set of 60 students.

S.No. of acti-vity.	Complete pairs.	Partial pairs.	Triads.	Quadruplets.
1.	-.4729	-.5483	-.5935	-.5899
2.	.0799	.0177	-.0061	.0316
3.	-.8672	-.8043	-.8032	-.9054
4.	.5326	.7172	.6980	.5213
5.	.1288	.0268	.1750	.2536
6.	.0836	.0175	.1332	.0865
7.	.4592	.6290	.4585	.3878
8.	.1632	.0297	.1059	.1412
9.	.4675	.3843	.4406	.3828
10.	-.1518	.0625	-.1630	-.0289
11.	-.2561	-.4727	-.2178	-.0853
12.	.7740	.8090	.7127	.6620
13.	-.9306	-.8273	-.8512	.8504

Similarly the ranks of the activities corresponding to the four methods of scaling as obtained from table 2 are presented in table 4 below.

TABLE 4.

Ranks of activities based on the same set of 60 students.

S.No. of stimulus.	Complete pairs.	Partial pairs.	Triads.	Quadruplets.
1.	11	11	11	11
2.	8	8	8	8
3.	12	12	12	13
4.	2	2	2	2
5.	6	7	5	5
6.	7	9	6	7
7.	4	3	3	3
8.	5	6	7	6
9.	3	4	4	4
10.	9	5	9	9
11.	10	10	10	10
12.	1	1	1	1
13.	13	13	13	12

INTER RATER CONSISTENCY.

In the table 5 the correlations are given between the two sets of scalevalues of the 13 activities for each scaling method as obtained from Group A and B of the students - halves of the sample of students. As mentioned in the earlier Chapter, two equivalent groups A and B consisting of 28 subjects each were formed. The correlations thus give split half reliability for each scaling method. The correlations in the first column are between scalevalues determined from Groups of 28 each. By applying spearman - Brown prophecy formula to these correlations, the obtained values can interpreted as those that would arise from two whole groups of 56 students each. These are reported in the last column of table 5. These figures indicate how for judges were consistent in their judgements. It shows that the judges were consistent for each of the scaling methods. Thus, so far consistency of judgements is concerned four methods are equally good.

TABLE 5.

Inter-rater consistency: Correlations between scale-values obtained from two equivalent groups.

Serial number	Methods.	Between two equivalent halves of 56;	Spearman Brown value for whole group of 56.
1.	Complete pairs.	.96	.98
2.	Partial pairs.	.98	.99
3.	Triads.	.90	.95
4.	Quadruplets.	.96	.98

INTER CORRELATIONS OF SCALEVALUES.

Table 6 shows correlations between scale-values, obtained by administrations of four forms (scaling methods) to four independent groups of 15 each. Correlations of scale-values obtained by partial, triad and quadruplet methods with the complete pairs method are .82, .84 and .60. All these are significant at .01 and .05 level except the last one which is significant only at 5% level. Test of significance of difference of correlations by using the appropriate t - statistic* reveals that

---

* $t = r_{12}-r_{13}\sqrt{\frac{1+r_{23}}{2(1-r_{12}^2-r_{13}^2-r_{23}^2+2r_{12}r_{13}r_{23})}}$
Statistical Inference Walker & Lev.

there is no significant difference between correlations of (i) complete pair form with partial pair forms and complete pair form with triads, and (ii) complete pair form with partial pairs and complete pairs with quadruplets. But there is a significant difference between correlations of complete pairs with triads and complete pairs with quadruplets. The correlations between partial pairs and triads, partial pairs and quadruplets and between triads and quadruplets are ; .87, .70 and .89 respectively. This shows that these short cut procedures among themselves are highly correlated. In table 6 95% confidence intervals corresponding to each correlations are also given in parenthesis. Since the four independent forms are assigned to four different groups of students the variability among students is likely to pull down the correlation values. There is likely to be large individual variations in preference of leisure time activities. Therefore, the correlations between the scalevalues obtained by the different methods may not be high, because in each method, a different group is involved. But the values we obtained are fairly high, showing that the four methods have a lot in common.

Inter Co-rrelations between the Scaling Methods. based on independent groups of 15 each.

S. No.	Name of methods.	Complete pairs.	Partial pairs.	Triads.	Quadruplets.
1.	Complete.	-	.82 $(.49 < \rho < .94)$	.84 $(.54 < \rho < .96)$	.60 $(.08 < \rho < .87)$
2.	Partial.	-	-	.87 $(.60 < \rho < .96)$	.70 $(.26 < \rho < .90)$
3.	Triads.	-	-	-	.89 $(.67 < \rho < .97)$

Note :- Within parenthesis 95% confidence intervals for r are given.

In Table 7, the correlations between the method are reported on the basis of the data obtained from the whole set of 60 students.

The correlations between complete pairs with partial pairs, triads and quadruplets are .97, .99 and .98. The other correlations in table 7 show that these short cut procedures of scaling are giving almost same

results. In the table, in parenthesis, intervals at 95% confidence are given corresponding to each of the correlation. In the case, with data from the same set of 60 subjects, when correlations are calculated, these are naturally higher than those obtained from the data from different groups of 15 subjects each.

TABLE 7.*

Intercorrelations of Scalevalues, based on judgements of 60 judges.

Method	Complete pairs.	Partial pairs.	Triads.	Quadruplets
Complete pairs.	-	.97 $(.90 < \rho$ $< .99)$	.99 $(.97 < \rho$ $1.00)$	.98 $(.98 < \rho$ $.99)$
Partial pairs.	-	-	.97 $(.90 < \rho$ $< .99)$	.96 $(.89 < \rho$ $< .99)$
Triads.				.99 $(.97 < \rho$ $< 1.00)$

* The 95% confidence intervals of each correlation are given in parentheses.

INTER CORRELATIONS OF RANK ORDERS.

In calculating rank correlations no assumption of normality of the trait is made for proper interpretation

of the values. In the case of small number of stimuli, it Rank correlations were therefore calculated to get supplementary information about the closeness of the results from the four methods.

In table 8, are given correlations between the ranks of the 13 activities obtained by the four methods of scaling as applied to four independent groups of 15 each.

These correlations were calculated from the ranks reported in table 3. The correlations are all fairly high.

TABLE 8.

Inter Correlations between ranks based on data from the independent groups of 15 each.

Method	Complete pairs.	Partial pairs.	Triads	Quadruplets
Complete pairs.	-	.85	.82	.88
Partial pairs.	-	-	.90	.72
Triads.	-	-	-	.82

In table 9, similar rank correlations are reported from the ranks given in table 4. All these correlations are high, indicating that all these four methods are almost equally effective in ranking a given set of stimuli.

TABLE 9.

Inter Correlations of rank orders, based on judgements of the same set of 60 students,

Name of method.	Complete pairs.	Partial pairs.	Triads.	Quadruplets
Complete pairs.	-	.93	.98	.99
Partial pairs.	-	-	.94	.93
Triads.	-	-	-	.92

ANALYSIS OF TIME DATA:

The time taken by students in completing a given form varied from student to student. The time for each student was durly recorded. The time data are reported in the Appendix A-34.

(a) ANALYSIS OF TIME DATA OF 4 INDEPENDENT GROUPS OF SIZE 15 EACH.

For the four methods of scaling, the four forms were in the first instance administered to 4 independent groups of 15 each.

Mean and standard deviations of times taken by the students are given in table 10 below.

TABLE 10.

Time taken by students in first administration of forms (in minutes) for 4 groups of 15 each.

Statistic \ Methods	Complete pairs.	Partial pairs.	Triads	Quadruplets
Mean.	13.87	11.63	12.13	11.50
Standard deviation.	2.705	1.455	1.140	2.540

This was like a simple randomised design. For testing significance of difference between means, the analysis of variance for one way classification has been carried out. The table of analysis of variance is given below.

TABLE 11.

Analysis of Variance.
(Simple randomised design)

Source of Variation.	df	S.S.	M.S.S.		
Treatments.	3	53.39	17.797	F	17.797 / 4.693
Error	56	262.80	4.693		
Total.	[illegible]	316.19			3.792*

---

* Significant at 5% level.

By using Newman-Keuls procedure (table given in Appendix A-35) for testing which means differ significantly from which other means. It is seen that the means of time corresponding to triads, quadruplets and partial pairs do not differ significantly from one another at 5% level of significance, so far as evidence from data from four independent groups of 15 is concerned. There of course differed significantly from the average time taken in complete pairs.

ANALYSIS OF TIME DATA OF THE WHOLE SET OF SIXTY JUDGES.

Times, taken by the 60 students by each of four methods are given in the appendix (A-34). Averages are summerised in table-12.

TABLE 12.

TIME

Average time taken by 60 judges in completing different forms.

Statistic / Method	Complete pairs.	Partial pairs.	Triads	Quadruplets.
Mean.	6.50	6.78	7.29	7.33

Here since the latin square lay-out was employed

to counter balance the order effects the appropriate analysis of variance was carried out following the procedure described in Winer's Statistical principles in experimental designs and table showing procedure is given in the Appendix A-36. The analysis of variance is given in table 13 below. The design could be considered as a cross over design.

TABLE 13.

ANALYSIS OF VARIANCE TABLE.

(Cross over design)

Source of variation.	df	S.S.	M.S.	F.
Subjects.	59	366.71	6.22	2.11
Treatments.	3	291.54	97.18	32.94
Treatments.				
Occassions.	3	1919.74	639.91	21.92
Error.	174	512.97	2.95	
Total :-	239	3090.96		

It is seen that the differences in average times taken by the four methods are highly significant. Also there is highly significant difference in the average times of the four occassions of administrations i.e. the four orders of presentation. In this case since from the error term the inter-individual variations have been removed, the error mean square (2.95) is much lower than that in the analysis

of variance of talbe 11. There the error m.s. included inter individual variations was 4.693. The tests of significance in the analysis of variation talbe 13 are thus more powerful than those of table 11.

The Newman-Keul's procedure (table is given in A-36) applied for the comparison of the means of table 12, leads to the conclusion that all the means differ significantly from one another. In table 11, the test was not powerful enough to bring out the significance of differences among the mean times of the triads, quadruplets and partial pairs procedures.

COEFFICIENT OF AGREEMENT.

The Coefficient of agreement between judges in each of the four forms i.e. complete pairs, partial pairs, triads and quadruplets are .237, .221, .236 and .222.* These figures are not high, because in respect of leisure time activities, the preferences of the students are not likely to be the same. But the coefficient of agreement is ranging from .222 to .237 for the four methods, indicating that all the students agree to the same extent with all the four methods. Thus so far as the extent of agreement among students is concerned, all the four methods are more or less equally effective given consistent results.

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* Formula for calculation coefficient of agreement is taken from 'Techniques of Attitude Scale Construction' by Edwards Albe.

TABLE 14.

COEFFICIENT OF AGREEMENT.

Complete	.237
Partial pairs.	.221
Triads.	.236
Quadruplets.	.229

CHAPTER VI.

DISCUSSIONS OF RESULTS AND CONCLUSIONS.

In this study the following four methods of scaling a given set of 13 stimuli have been compared empirically.

1. Complete pairs involving 78 pairs.
2. Partial pairs involving 39 pairs.
3. Triads involving a balanced set of 26 triads, and
4. Quadruplets involving a balanced set of 13 quadruplets.

The 13 stimuli chosen were 13 leisure time activities and the judges (the students of XI class in a college) were asked to indicate their order of preferences for these 13 activities by each of the four methods. So with each method the scalevalues were determined for each of the 13 activities and there were compared to find out to what extent the four methods lead to the same scale values. Also the average time taken with each method was calculated to find out which method took least time and the average times differed

significantly for the four methods.

In one type of analysis, only the data for the four methods as tried on four independent randomly formed groups of 15 each were considered. In this case because of small size of each group and because of large individual variations in the matter of preferences of the leisure time activities, very high correlations are not expected between the scalevalues obtained by the different methods. It is found that the rank correlations between the methods varies from .58 to .86 and product moment correlations between scale values varies from .60 to .84. Time taken by judges in rating task is 82% in quadruplet and partial pairs and 84% in triads of the average time taken in complete pairs.

In another type of analysis, the scale values of the activities were obtained by each of the four methods tried on the same set of 60 students of the sample. Of course the design was such that no one method was unduly favoured. The order effects were properly counter balanced. Here if the four methods are equally effective. It is expected that they would lead to almost identical scale values, because they are used on the same set of 60 subjects. There may be some effect of memory influencing the responsis to the forms that were given to the students on the 2nd, 3rd and 4th occasions. The triads and quadruplets are very different in nature and so the bias due to memory probably would not be serious. More over such effects if any would equally influence all the four methods, as order effects

are counter balanced or equally distributed over all the four methods.

Here product moment correlations between scale-values are ranging from .97 to .99. The rank correlations are between .93 to .99. The time taken by judges in rating task is 66% in partial pairs, 77% in triads and 86% in quadruplets of the average time consumed in complete pairs. 50 complete pairs take maximum time.

Though the average times differ significantly for the four methods, it is expected that the differences would become sharper had a similar comparison been made for more than 13 stimuli. Some time is spent in following the for each case. This would become a small fraction of total time in case there are a large number of stimuli. It is not possible to generalise the results about 'average time', it would depend on the nature and number of stimuli, length of instructions etc, but it seems that in a situation similar to the present the least time would be required in partial pairs, some more in triads and quadruplets and maximum time consumed in complte pairs of course. In a similar situations, the short cut procedures can be used in stead of the complete pairs comparison without making serious difference to the scale-values and the ranks of stimuli. These short cut procedures will result in saving of time. These procedures will be more useful in the situations, where the number of stimuli is large.

Coefficients of agreement between judges in these four methods are ranging from .222 to .237. These are not high, but in case of leisure time activities much agreement is not expected. It shows a trend whatever degree of agreement there exists, it is the same will for all the methods of scaling.

Inter rater reliability figures in these four methods are ranging from .98 to .99. It shows that judges are equally consistent in each of four methods. It apparently means that consistency is not direct function of time, which raters consume.

LIMITATIONS OF STUDY.

This study is based on a sample of 60 individuals only. For the comparison between the four methods based on data from 4 independent groups, the size of each group is just 15. The stimuli in this study are such that agreement among judges is not much. The results can be generalised to only such stimuli. The others have earlier worked with other types of stimuli. Here also the four methods could be compared using other types of stimuli. There are only 12 stimuli. It would be of interest to see what would happen with more stimuli.

* * *

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LIST OF APPENDICES.

A-1 List of Leisure Time Activity in Hindi.
A-2 Arrangement for complete pairs for presentation.
A-3 Final Form of Complete Pairs with Instructions.
A-4 Scheme of Partial Pair Arrangement.
A-5 Final Form of Partial Pairs with Instructions.
A-6 Scheme of Triads Arrangement.
A-7 Final Form of Triads with Instructions.
A-8 Scheme of Quadruplet Arrangement.
A-9 Final Form of Quadruplets with Instructions.
A-10. F-Matrix, Complete Pair Form, Based on Judgement of sixty judges.
A-11 F-Matrix. Partial Pair Form, Based on Judgement of sixty judges.
A-12 F-Matrix. Triad Form, Based on Judgements of sixty judges,kh
A-13. F-Matrix, Quadruplet Form, Based on Judgements of sixty judges.
A-14. F-Matrix, Complete Form, Based on First Random Half of Universe of 56 Judges.
A-15. F-Matrix, Complete Pair Form, Based on Second Random Half of Universe of 56 Judges.
A-16. F-Matrix, Partial Pair Form, Based on Second Random Half of Universe of 56 judges.
A-17. F-Matrix, Partial Pair Form, Based on First Random Half of universe of 56 judges.
A-18. F-Matrix, Triad Form, Based on First Random Half of Universe of 56 Judges.
A-19. F-Matrix, Triad Form, Based on Second Random Half of Universe of 56 Judges.
A-20. F-Matrix, Quadruplet Form, Based on First Random Half of Universe of 56 judges.
A-21. F-Matrix, Quadruplet Form, Based on Second Random Half of Universe of 56 Judges.

A-22. F-Matrix, Complete Pair Form, Based on judgement of 15 Judges.

A-23. F-Matrix, Partial Pair Form, Based on judgement of 15 Judges.

A-24. F-Matrix, Triad Form, Based on judgements of 15 judges.

A-25, F-Matrix, Quadruplet Form, Based on judgements of 15 judges.

A-26. P-Matrix, Complete Pair Form, Based on judgement of sixty judges.

A-27. P-Matrix, Partial Pair Form, Based on judgements of Sixty-judges.

A-28. P-Matrix, Triad Form, based on judgements of sixty judges.

A-29. Proportion Matrix, Quadruplet Forms, based on judgements of sixty judges.

A-30. Z-Matrix, Complete Pair Form,

A-31. Z-Matrix, Partial Pair Form,

A-32. Z-Matrix, Triad Form,

A-33, Z-Matrix, Quadruplets Form.

A-34. Time Data,

A-35. Test of Significance, Newman Kuels Procedure.

A-36. Test of Significance of Time Average.

A-I

List of leisure time activities in Hindi

(1) सिनेमा देखना

(2) वाद्य संगीत या गाने द्वारा मनोरंजन करना

(3) मित्रों के साथ गप - शप लगाना

(4) खुली जगह में टहलना

(5) मैच (क्रिकेट, हाकी, आदि के) देखना

(6) पत्रिकाएँ देखना

(7) अखबार पढ़ना

(8) उपन्यास पढ़ना

(9) रेडियो सुनना

(10) परिवार के लोगों के साथ बातचीत करना

(11) एकान्त में आराम करना

(12) खुले मैदान के खेल खेलना

(13) घर में बैठ कर (ताश, कैरम, आदि) खेलना

A-2

Arrangement fof complete pairs for presentation.

1. (a) 1
   (b) 2

2. (a) 13
   (b) 3

3. (a) 12
   (b) 4

4. (a) 11
   (b) 5

5. (a) 10
   (b) 6

6. (a) 9
   (b) 7

7. (a) 1
   (b) 8

8. (a) 2
   (b) 3

9. (a) 13
   (b) 4

10. (a) 12
    (b) 5

11. (a) 11
    (b) 6

12. (a) 10
    (b) 7

13. (a) 9
    (b) 8

14. (a) 1
    (b) 3

15. (a) 2
    (b) 4

16. (a) 13
    (b) 5

17. (a) 12
    (b) 6

18. (a) 11
    (b) 7

19. (a) 10
    (b) 8

20. (a) 1
    (b) 9

21. (a) 3
    (b) 4

22. (a) 2
    (b) 5

23. (a) 13
    (b) 6

24. (a) 12
    (b) 7

25. (a) 11
    (b) 8

26. (a) 10
    (b) 9

27. (a) 1
    (b) 4

28. (a) 3
    (b) 5

29. (a) 2
    (b) 6

30. (a) 13
    (b) 7

31. (a) 12
    (b) 8

32. (a) 11
    (b) 9

33. (a) 1
    (b) 10

34. (a) 4
    (b) 5

35. (a) 3
    (b) 6

36. (a) 2
    (b) 7

37. (a) 13
    (b) 8

38. (a) 12
    (b) 9

39. (a) 11
    (b) 10

40. (a) 1
    (b) 5

41. (a) 4
    (b) 6

42. (a) 3
    (b) 7

43. (a) 2
    (b) 8

44. (a) 13
    (b) 9

45. (a) 12
    (b) 10

Contd. .... A-2)

46. (a) 1
(b) 11

47. (a) 5
(b) 6

48. (a) 4
(b) 7

49. (a) 3
(b) 8

50. (a) 2
(b) 9

51. (a) 13
(b) 10

52. (a) 12
(b) 11

53. (a) 1
(b) 6

54. (a) 5
(b) 7

55. (a) 4
(b) 8

56. (a) 3
(b) 9

57. (a) 2
(b) 10

-58. (a) 13
(b) 11

59. (a) 1
(b) 12

60. (a) 6
(b) 7

61. (a) 5
(b) 8

62. (a) 4
(b) 9

63. (a) 3
(b) 10

64. (a) 2
(b) 11

65. (a) 13
(b) 12

66. (a) 1
(b) 7

67. (a) 6
(b) 8

68. (a) 5
(b) 9

69. (a) 4
(b) 10

70. (a) 3
(b) 11

71. (a) 2
(b) 12

72. (a) 1
(b) 13

73. (a) 7
(b) 8

74. (a) 6
(b) 9

75. (a) 5
(b) 10

76. (a) 4
(b) 11

77. (a) 3
(b) 12

78. (a) 2
(b) 13

७१- (अ) वाद्य संगीत या गाने द्वारा मनोरंजन करना
(ब) खुले मैदान में खेल खेलना

७२- (अ) सिनेमा देखना
(ब) घर में बैठ कर (ताश, कैरम, आदि) खेलना

७३- (अ) अखबार पढ़ना
(ब) उपन्यास पढ़ना

७४- (अ) पत्रिकायें देखना
(ब) रेडियो सुनना

७५- (अ) मैच (क्रिकेट, हाकी, आदि के) देखना
(ब) परिवार के लोगों के साथ बातचीत करना

७६- (अ) खुली जगह में टहलना
(ब) एकान्त में आराम करना

७७- (अ) मित्रों के साथ गप-शप लगाना
(ब) खुले मैदान में खेल खेलना

७८- (अ) वाद्य संगीत या गाने द्वारा मनोरंजन करना
(ब) घर में बैठ कर (ताश, कैरम, आदि) खेलना

A-4

Scheme of Partial pair arrangement.

1. (a) 1
(b) 2

2. (a) 3
(b) 13

3. (a) 11
(b) 5

4. (a) 6
(b) 12

5. (a) 10
(b) 7

6. (a) 9
(b) 8

7. (a) 4
(b) 1

8. (a) 3
(b) 2

9. (a) 13
(b) 6

10. (a) 5
(b) 12

11. (a) 10
(b) 11

12. (a) 1
(b) 8

13. (a) 7
(b) 4

14. (a) 2
(b) 9

15. (a) 6
(b) 3

16. (a) 13
(b) 10

17. (a) 8
(b) 5

18. (a) 11
(b) 4

19. (a) 7
(b) 1

20. (a) 12
(b) 9

21. (a) 4
(b) 3

22. (a) 2
(b) 5

23. (a) 8
(b) 11

24. (a) 1
(b) 13

25. (a) 6
(b) 7

26. (a) 10
(b) 8

27. (a) 8
(b) 2

28. (a) 5
(b) 4

29. (a) 12
(b) 13

30. (a) 9
(b) 6

31. (a) 11
(b) 1

32. (a) 4
(b) 10

33. (a) 7
(b) 3

34. (a) 2
(b) 12

35. (a) 5
(b) 6

36. (a) 9
(b) 10

37. (a) 13
(b) 7

38. (a) 12
(b) 11

39. (a) 3
(b) 9

A-8

Scheme of Triads arrangement.

1. (a) 2
(b) 3
(c) 9

2. (a) 2
(b) 4
(c) 10

3. (a) 3
(b) 5
(c) 11

4. (a) 4
(b) 6
(c) 12

5. (a) 5
(b) 7
(c) 13

6. (a) 1
(b) 6
(c) 8

7. (a) 2
(b) 7
(c) 9

8. (a) 3
(b) 8
(c) 10

9. (a) 4
(b) 9
(c) 11

10. (a) 5
(b) 10
(c) 12

11. (a) 6
(b) 11
(c) 13

12. (a) 1
(b) 7
(c) 12

13. (a) 2
(b) 8
(c) 13

14. (a) 2
(b) 5
(c) 6

15. (a) 3
(b) 6
(c) 7

16. (a) 4
(b) 7
(c) 8

17. (a) 5
(b) 8
(c) 9

18. (a) 6
(b) 9
(c) 10

19. (a) 7
(b) 10
(c) 11

20. (a) 8
(b) 11
(c) 12

21. (a) 9
(b) 12
(c) 13

22. (a) 1
(b) 10
(c) 13

23. (a) 1
(b) 2
(c) 11

24. (a) 2
(b) 3
(c) 12

25. (a) 3
(b) 4
(c) 13

26. (a) 1
(b) 4
(c) 5

२१- (अ) रेडियो सुनना
(ब) घर में बैठ कर (ताश, कैरम, आदि) खेलना
(स) खुले मैदान के खेल खेलना

२२- (अ) परिवार के लोगों के साथ बातचीत करना
(ब) सिनेमा देखना
(स) घर में बैठ कर (ताश, कैरम, आदि) खेलना

२३- (अ) एकान्त में आराम करना
(ब) वाद्य संगीत या गाने द्वारा मनोरंजन करना
(स) सिनेमा देखना

२४- (अ) खुले मैदान के खेल खेलना
(ब) मित्रों के साथ गप-शप लगाना
(स) वाद्य संगीत या गाने द्वारा मनोरंजन करना

२५- (अ) घर में बैठ कर (ताश, कैरम, आदि) खेलना
(ब) खुली जगह में टहलना
(स) मित्रों के साथ गप-शप लगाना

२६- (अ) सिनेमा देखना
(ब) मैच (क्रिकेट, हाकी, आदि के) देखना
(स) खुली जगह में टहलना

A-8

Scheme of Quadruplet arrangement.

(a) 13
(b) 1
(c) 3
(d) 9

(a) 1
(b) 2
(c) 4
(d) 10

(a) 2
(b) 3
(c) 5
(d) 11

(a) 3
(b) 4
(c) 6
(d) 12

(a) 4
(b) 5
(c) 7
(d) 13

(a) 5
(b) 6
(c) 8
(d) 1

7. (a) 6
(b) 7
(c) 9
(d) 2

8. (a) 7
(b) 8
(c) 10
(d) 3

9. (a) 8
(b) 9
(c) 11
(d) 4

10. (a) 9
(b) 10
(c) 12
(d) 5

11. (a) 10
(b) 11
(c) 13
(d) 6

12. (a) 11
(b) 12
(c) 2
(d) 7

13. (a) 12
(b) 13
(c) 2
(d) 8

* * *

९- (अ) उपन्यास पढ़ना
(ब) रेडियो सुनना
(स) एकान्त में आराम करना
(द) खुली जगह में टहलना

१०- (अ) रेडियो सुनना
(ब) परिवार के लोगों के साथ बातचीत करना
(स) खुले मैदान के खेल खेलना
(द) मैच (क्रिकेट, हाकी आदि के) देखना

११- (अ) परिवार के लोगों के साथ बातचीत करना
(ब) एकान्त में आराम करना
(स) घर में बैठ कर (ताश, कैरम, आदि) खेलना
(द) पत्रिकाएँ देखना

१२- (अ) एकान्त में आराम करना
(ब) खुले मैदान के खेल खेलना
(स) सिनेमा देखना
(द) अखबार पढ़ना

१३-(अ) खुले मैदान के खेल खेलना
(ब) घर में बैठ कर (ताश, कैरम, आदि) खेलना
(स) वाद्य संगीत या गाने द्वारा मनोरंजन करना
(द) उपन्यास पढ़ना

A-10

FREQUENCY MATRIX
(Complete Pair Form)
Based on Judgements of 60 Judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		16	36	7	15	19	16	14	11	21	25	9	38
2	44		51	16	28	33	22	31	19	36	35	12	52
3	24	9		6	9	10	5	12	4	10	17	3	35
4	53	44	54		39	38	30	38	29	50	48	21	55
5	45	32	51	21		29	21	26	23	40	41	13	51
6	41	27	50	22	31		14	26	19	41	42	18	50
7	44	38	55	30	39	46		37	25	47	46	21	54
8	44	29	48	22	34	34	23		26	38	40	21	47
9	49	41	56	31	37	41	35	34		43	41	20	56
10	39	24	50	10	20	19	13	26	17		37	10	51
11	35	25	43	12	19	18	14	20	19	23		12	46
12	51	48	57	39	47	42	39	39	40	30	48		58
13	22	8	25	5	9	10	6	13	5	9	14	2	

A-11

FREQUENCY MATRIX

PARTIAL PAIR FORM.

Based on judgements of sixty judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		15		5			12	19			24		38
2	45		48		26			29	18			16	
3		12		8		12			7	10			33
4	55		52		39		30			39	51		
5		34		21		30		31			46	22	
-6			48		30		13		21			60	48
7	48			30		47		39		46			51
8	41	31			29		21		23		39		
9		42	53			39		37		39		19	
10			50	21			14		21		33		47
11	36			9	15			21		27		11	
12		45			38	44			41		49		58
13	22		27			12	9			13		2	

A-12

FREQUENCY MATRIX

(TRIAD FORM)

Based on the Judgements of sixty Judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		18	40	9	13	17	11	16	6	15	17	5	35
2	42		53	12	30	29	18	30	19	30	31	11	50
3	20	7		5	6	8	6	26	3	33	14	5	31
4	51	48	55		44	37	32	36	33	49	50	27	55
5	47	30	54	16		28	21	33	26	35	44	18	51
6	43	31	52	23	32		15	27	23	36	42	17	52
7	49	42	54	28	39	45		34	25	45	47	24	52
8	44	30	34	24	27	33	26		25	38	35	23	50
9	54	41	57	27	34	37	35	35		44	43	19	48
10	45	30	27	11	25	24	15	22	16		32	14	52
11	43	29	46	10	16	18	13	25	17	28		8	47
12	55	49	55	33	42	43	36	37	41	46	52		56
13	25	10	29	5	9	8	8	10	12	8	13	4	

A-13

FREQUENCY MATRIX

QUADRUPLETS FORM

Based on the judgements of sixty judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		18	39	7	9	10	11	16	6	19	22	7	41
2	42		47	18	28	29	19	31	19	33	30	17	52
3	21	13		4	6	10	5	12	4	8	14	4	35
4	53	42	56		35	34	26	39	38	47	49	26	52
5	51	32	54	25		35	24	33	30	36	37	20	49
6	50	31	50	26	25		17	27	17	35	37	16	49
7	49	41	55	34	36	43		33	29	38	37	19	51
8	44	29	48	21	27	33	27		25	34	35	25	50
9	54	41	56	22	30	43	31	35		34	36	17	55
10	41	27	52	13	24	25	22	26	26		28	15	48
11	38	30	46	11	23	23	23	25	24	32		11	49
12	53	43	56	34	40	44	41	35	43	45	49		54
13	19	8	25	8	11	11	9	10	5	12	11	6	

A-14

FREQUENCY MATRIX

(Complete Pair Form)

Based on first random half of universe of fifty-six judges.

Group A.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		6	15	5	8	9	6	8	3	8	11	4	16
2	22		23	8	14	17	11	17	5	17	15	6	25
3	13	5		3	5	6	2	7	2	6	9	2	20
4	23	20	25		19	18	16	20	12	23	23	11	25
5	20	14	23	9		18	9	13	10	17	21	5	24
6	19	11	22	10	10		5	15	6	17	18	10	25
7	22	17	26	12	19	23		21	10	23	20	11	26
8	20	11	22	8	15	13	7		12	14	16	7	24
9	25	23	26	16	18	22	18	16		22	21	11	27
10	20	11	22	5	11	11	5	14	6		18	4	25
11	17	13	19	5	7	10	8	12	7	10		5	21
12	24	22	26	17	23	18	17	21	17	24	23		28
13	12	3	8	3	4	3	2	4	1	3	7	0	

A-15

FREQUENCY MATRIX

(Complete Pair Form)

Based on first random half of universe of fifty-six judges.

Group B

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		9	18	1	6	8	7	9	7	11	9	4	19
2	19		24	8	13	13	7	12	12	16	16	5	23
3	10	4		3	2	4	3	5	3	4	8	1	14
4	27	20	25		16	17	12	15	15	23	22	9	26
5	22	15	26	12		11	9	12	12	20	17	7	23
6	20	15	24	11	17		5	11	12	21	20	6	22
7	21	21	25	16	19	23		15	15	22	22	8	24
8	19	16	23	13	16	17	13		12	18	21	12	20
9	21	16	25	13	16	16	13	16		19	21	9	25
10	17	12	24	5	8	7	6	10	9		16	6	23
11	19	12	20	6	11	8	6	7	7	12		7	21
12	24	23	27	19	21	22	20	16	19	22	21		27
13	9	5	14	2	5	6	4	8	3	5	7	1	

A-16.

FREQUENCY MATRIX

(Partial Pair Form)

Based on second random half of universe of fifty-six judges.

Group B.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.		6		2			7	9			10		19
2.	22		24		14			14	8			3	
3.		4		4		4			4	3			15
4.	26		25		18		17			18	24		
5.		14		10		16		16			20	11	
6.			24		12		4		9			7	23
7.	21			11		24		18		22			23
8.	19	14			12		10		10		18		
9.		20	24			19		18		18		7	
10.			25	10			6		10		15		23
11.	18			4	8			10		13		3	
12.		25			17	21			21		25		28
13.	9		13			5	5			5		0	

A-17

FREQUENCY MATRIX

(Partial Pair Form)

Based on first random half of universe of fifty-six judges.

Group A.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		8		4			4	9			12		16
2	20		21		12			14	9			10	
3		7		5		7			3	8			17
4	24		23		19		12			18	24		
5		16		9		11		13			21	8	
6			21		17		8		19			7	23
7	24			10		20		19		20			25
8	19	14			15		9		10		18		
9		19	25			18		18		17		10	
10			20	10			8		11		17		23
11	16			4	7			10		11		7	
12		18			20	21			18		21		26
13	12		11			5	9			5		2	

A-18

FREQUENCY MATRIX

(Triad Form)

Based on first random half of universe of fifty-six judges.

Group A

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		6	20	5	7	9	5	9	4	6	9	2	17
2	22		23	4	11	12	9	17	9	12	16	4	24
3	8	5		3	3	6	4	12	3	11	6	2	16
4	23	24	25		7	19	15	17	17	21	22	11	26
5	21	17	25	21		12	10	18	13	18	20	10	26
6	19	16	22	9	16		6	12	11	13	20	7	24
7	23	19	24	13	18	22		17	10	11	22	9	25
8	19	11	16	11	20	16	11		9	14	14	8	23
9	24	19	25	11	15	17	18	19		18	19	8	22
10	22	16	17	7	10	15	17	14	10		20	7	24
11	19	12	22	6	8	8	6	14	9	8		3	21
12	26	24	26	17	18	21	19	20	20	21	25		26
13	11	4	12	2	2	4	3	5	6	4	7	2	

A-19

FREQUENCY MATRIX.

(Triad Form)

Based on second random half of universe of fifty-six judges.

Group B.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		8	18	3	7	6	3	5	1	9	9	1	17
2	20		26	5	18	17	8	10	8	17	13	6	23
3	10	2		2	2	1	0	13	0	17	5	2	15
4	25	23	26		22	16	13	15	12	25	22	16	24
5	21	10	26	6		12	8	12	9	15	20	6	21
6	22	11	27	12	16		7	11	9	19	20	8	25
7	25	20	28	15	20	21		14	13	22	20	14	25
8	23	18	15	13	16	17	14		15	20	18	14	25
9	27	20	18	16	19	19	15	13		22	22	23	23
10	19	11	11	3	13	9	6	8	6		11	5	24
11	19	15	23	6	8	8	8	10	6	17		3	22
12	27	22	26	12	22	20	14	14	5	23	25		26
13	11	5	13	4	7	3	3	3	5	4	6	2	

A-20

FREQUENCY MATRIX

(Quadruplet Form)

Based on first random half of universe of fifty-six judges.

Group A

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		7	18	4	6	7	7	8	4	10	11	4	22
2	21		20	10	15	15	8	17	6	14	15	10	26
3	10	8		3	4	4	4	8	3	4	8	1	19
4	24	18	25		17	17	12	21	18	22	24	12	24
5	22	13	24	11		18	12	19	16	17	18	8	26
6	21	13	24	11	10		7	12	6	17	17	5	24
7	21	20	24	16	16	21		17	11	16	14	7	28
8	20	11	20	7	9	16	11		8	12	15	10	22
9	24	22	25	10	12	22	17	20		16	16	7	28
10	18	14	24	6	11	11	12	16	12		15	7	22
11	17	13	20	4	10	11	14	13	12	13		3	24
12	24	18	27	16	20	23	21	18	21	21	25		27
13	6	2	9	4	2	4	0	6	0	6	4	1	

A-21

FREQUENCY MATRIX

(Quadruplet Form)

Based on second random half of universe of fifty-six judges.

Group B

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		10	20	3	4	4	4	7	2	9	11	3	19
2	18		24	6	12	13	10	14	11	15	14	8	24
3	8	4		1	2	6	1	3	1	3	14	2	15
4	25	22	27		17	16	11	16	17	21	21	10	26
5	24	16	26	11		14	11	13	12	16	17	12	23
6	24	15	22	12	14		8	13	9	16	19	9	21
7	24	18	27	17	17	20		14	15	20	19	12	23
8	21	14	25	12	15	15	14		13	18	18	11	24
9	26	17	27	11	16	19	13	15		18	19	9	24
10	19	13	25	7	12	12	8	10	10		12	9	24
11	17	14	14	7	11	9	9	10	9	16		7	21
12	25	20	26	18	16	19	16	17	19	19	21		24
13	9	4	13	2	5	7	5	4	4	4	7	4	

A-22

FREQUENCY MATRIX

(Complete Pair Form)

Based on judgements of fifteen judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		3	9	4	6	4	5	5	5	7	8	4	10
2	12		14	9	12	11	8	11	10	12	11	5	13
3	6	1		3	4	2	1	3	2	2	6	1	6
4	11	6	12		9	11	9	10	6	10	10	5	12
5	9	3	11	6		7	5	6	5	7	8	3	10
6	11	4	13	4	8		4	6	5	8	10	2	10
7	10	7	14	6	10	11		10	7	9	11	4	11
8	10	4	12	5	9	9	5		6	10	9	4	10
9	10	5	13	6	10	10	8	9		8	12	4	12
10	8	3	13	5	8	7	6	5	7		10	3	12
11	7	4	9	5	7	5	4	6	3	5		3	9
12	11	10	14	10	12	13	11	11	11	12	12		14
13	5	2	9	3	5	5	4	5	3	3	6	1	

A-23

FREQUENCY MATRIX

(Partial Pair Form)

Based on judgements of fifteen judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		2		0			3	4			6		6
2	13		13		8			6	4			4	
3		2		2		3			3	2			8
4	15		13		9		11			12	14		
5		7	6	6		10		6			13	9	
6			12		5		3		6			4	12
7	12			4		12		10		12			12
8	11	9			9		5		8		12		
9		11	12			9		7		10		4	
10			13	3			3		5		12		10
11	9			1	2			3		3		2	
12		11			6	11			11		13		15
13	9		7			3	3			5		0	

9	16	12	16	7	10	8	9	9		11	12	3	12
10	12	10	9	1	7	7	6	5	4		9	4	14
11	12	6	11	2	3	5	4	8	3	6		1	14
12	16	14	16	9	11	11	9	11	12	11	14		16
13	4	2	5	1	1	1	1	1	3	1	1	0	

A-24

FREQUENCY MATRIX

(Tried Form)

Based on judgements of fifteen judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		6	10	2	4	2	4	3	0	3	3	0	11
2	9		14	3	6	5	5	6	3	5	9	1	13
3	5	1		1	0	2	1	4	0	6	2	0	10
4	13	12	14		12	9	9	10	8	14	13	6	14
5	11	9	15	3		7	4	8	5	8	12	4	14
6	13	10	13	6	8		4	5	7	8	12	4	14
7	11	10	14	6	11	11		8	6	9	11	6	14
8	12	9	11	5	7	10	7		6	10	10	4	14

A-26

FREQUENCY MATRIX

(Quadruplet Form)

Based on the Judgement of fifteen judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		6	9	0	1	1	1	2	0	3	2	0	9
2	9		9	2	4	5	2	5	3	5	4	2	13
3	6	6		2	3	4	1	3	2	2	2	2	13
4	15	13	13		5	8	1	10	11	13	10	9	13
5	14	11	12	10		8	5	7	11	10	9	9	14
6	14	10	11	7	7		5	6	4	12	8	7	14
7	14	13	14	14	10	10		8	9	11	8	5	15
8	13	10	12	5	8	9	7		5	10	5	8	14
9	15	12	13	4	4	11	6	10		8	7	4	15
10	12	10	13	2	5	3	4	5	7		4	4	14
11	13	11	13	5	6	7	7	10	8	11		5	15
12	15	13	13	6	6	8	10	7	11	11	10		14
13	6	2	2	2	1	1	0	1	0	1	0	1	

A-28

PROPORTION MATRIX

(Complete Pairing Form)

Based on the judgements of sixty judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		.267	.600	.117	.250	.317	.267	.267	.183	.350	.417	.150	.633
2.	.733	,	.850	.267	.467	.550	.367	.517	.317	.600	.583	..200	.867
3.	.400	.150		.100	.150	.167	.083	.200	.067	.167	.283	.050	.583
4.	.883	.733	.900		.650	.633	.500	.633	.483	.833	.800	..350	.917
5.	.750	.733	.850	.350		.483	.350	.433	.383	.667	.683	.217	.850
6.	.683	.450	.833	.367	.517		.233	.433	.317	.683	.700	.300	.833
7.	.733	.633	.917	.500	.650	.767		.617	.417	.783	.767	.350	.900
8.	.733	.483	.800	.367	.567	.567	.383		.433	.583	.667	.350	.783
9.	.817	.683	.933	.517	.617	.683	.583	.567		.717	.683	.333	.917
10	.650	.400	.833	.167	.333	.317	.217	.417	.283		.617	.167	.850
11	.583	.417	.717	.200	.317	.300	.233	.333	.317	.383		.200	.767
12	.850	.800	.950	.650	.783	.700	.650	.650	.667	.833	.800		.967
13	.367	.133	.417	.083	.150	.167	.100	.217	.083	.150	.233	..033	

A-27

PROPORTION MATRIX

(Partial Pair Form)

Based on judgements of sixty judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		.250		.083			.200	.317			.400		.633
2			.800		.433			.483	.300			.250	
3				.133		.200			.117	.167			.550
4					.650		.600			.650	.850		
5						.500		.517			.750	.367	
6							.217		.350			.267	.800
7								.850		.767			.850
8									.383		.650		
9										.650		.317	
10											.550		.783
11												.183	
12													.967
13													

Note :- $p_{ij} = 1-p_{ji}$

A-28

PROPORTION MATRIX

(Triad Form)

Based on judgements of sixty judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		.300	.667	.150	.217	.283	.183	.267	.100	.250	.283	.083	.583
2			.883	.200	.500	.483	.300	.500	.317	.600	.517	.183	.833
3				.083	.100	.133	.100	.433	.050	.550	.233	.083	.517
4					.733	.617	.533	.600	.550	.817	.833	.450	.917
5						.467	.350	.550	.433	.583	.733	.300	.850
6							.250	.450	.383	.600	.700	.283	.867
7								.567	.417	.750	.783	.400	.867
8									.417	.633	.583	.383	.833
9										.733	.717	.317	.800
10											.533	.233	.867
11												.133	.783
12													.983
13													

Note : $p_{ij} = 1 - p_{ji}$

A-29

PROPORTION MATRIX.

(Quadruplet Form)

Based on judgements of sixty judges.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1		.300	.650	.117	.150	.167	.183	.267	.100	.317	.367	.117	.683
2			.783	.300	.467	.483	.317	.517	.317	.550	.500	.283	.867
3				.067	.100	.167	.083	.200	.067	.133	.233	.067	.583
4					.583	.567	.433	.650	.533	.783	.817	.433	.867
5						.583	.400	.550	.500	.600	.617	.283	.817
6							.283	.450	.283	.583	.617	.267	.817
7								.550	.483	.633	.617	.317	.850
8									.417	.567	.583	.417	.833
9										.567	.600	.283	.917
10											.467	.250	.800
11												.183	.817
12													.900
13													

Note :- $p_{ij} = 1-p_{ji}$

A-30

Z-Matrix

(Complete Pair Form)

Based on judgments of sixty judges.

	1	2	3	4	5	6	7
1.		-.622	.253	-1.190	-.674	-.476	-.622
2.			1.036	-.622	-.083	.126	-.340
3.				-1.282	-1.036	-.966	-1.385
4.					.385	.340	.0000
5.						-.043	-.385
6.							-.789
7.							
8.							
9.							
10.							
11.							
12.							
13.							

Contd............A-30)

8	9	10	11	12	13
-.622	-.904	-.385	-.210	-1.036	.340
.043	-.476	.253	.210	-.842	1.112
-.842	-1.499	-.966	-.574	-1.645	.210
.340	-.043	.966	.842	-.385	1.385
-.169	-.298	.432	.476	-.782	1.036
-.169	-.476	.476	.524	-.524	.966
.298	-.210	.782	.729	-.385	1.282
	-.169	.210	.432	-.385	.782
		.574	.476	-.432	1.385
			.298	-.966	1.036
				-.842	.729
					1.838

Note :- $Z_{ij} = -Z_{ji}$

A-31

Z - MATRIX

(Partial Pair Form)

Based on judgments of sixty judges.

	1	2	3	4	5	6	7
1.		-.674		-1.385			-.842
2.			.842		-.169		
3.				-1.112		-.842	
4.					.385		.000
5.						.0000	
6.							-.782
7.							
8.							
9.							
10.							
11.							
12.							
13.							

Note:- $Z_{ij} = -Z_{ji}$

Contd..............A-21)

8	9	10	11	12	13
-.476			-.259		.340
-.043	-.524			-.574	
	-1.130	-.966			.126
		.285	1.036		
.043			.674	-.340	
	-.385			-.622	.842
.385		.729			1.036
	-.298		.385		
		.385		-.476	
			.126		.782
				-.904	
					1.838

A-32

Z-Matrix

(Triad Form)

Based on judgements of sixty judges.

	1	2	3	4	5	6	7
1.		-.524	.432	-1.036	-.782	-.674	-.804
2.			1.190	-.842	.0000	-.043	-.524
3.				-1.385	-1.282	-1.112	-1.282
4.					.622	.298	.083
5.						-.033	-.385
6.							-.674
7.							
8.							
9.							
10.							
11.							
12.							
13.							

Note :- $Z_{ij} = -Z_{ji}$

Contd. .... A-32)

8	9	10	11	12	13
-.622	-1.282	-.674	-.574	-1.385	.210
.000	-.476	.000	.043	-.904	.966
-.169	-1.645	.126	-.729	-1.385	.043
.253	.126	.904	.966	-.126	1.385
.126	-1.169	.210	.622	-.524	1.036
-.126	-.298	.253	.524	-.574	1.112
.169	-.210	.674	.782	-.253	1.112
	-.210	.340	.210	-.298	.966
		.622	.574	-.476	.842
			.083	-.729	1.112
				-1.112	.782
					1.499

A-33

Z - MATRIX

(Quadruplet Form)

Based on judgements of sixty judges.

	1	2	3	4	5	6	7
1.		-.524	.385	-1.190	-1.036	-.966	-.904
2.			.782	-.524	-.083	-.043	-.476
3.				-1.499	-1.282	-.966	-1.385
4.					.210	.169	-.169
5.						.210	-.253
6.							-.574
7.							
8.							
9.							
10.							
11.							
12.							
13.							

Note :- $Z_{ij} = -Z_{ji}$

Contd.........A-33)

8	9	10	11	12	13
-.622	-1.282	-.476	-.340	-1.190	.476
.043	-.476	.126	.000	-.674	1.112
-.842	-1.499	-1.112	-.729	-1.499	.210
.385	.340	.782	.904	-.169	1.112
.126	.000	.253	.298	-.432	.904
-.126	-.571	.210	.298	-.622	.904
.126	-.043	.340	.298	-.476	1.036
	-.210	.169	.210	-.210	.966
		.169	.253	-.674	1.386
			-.083	-.674	.842
				-.904	.904
					1.282

A-34

TIME DATA

(In Minutes).

Group Ist.

S.No.	Ist Order (Complete)	IInd Order (Triad)	IIIrd Order (Quadruplet)	IVth Order (Partial)
1.	14	7	7	2
2.	14	9	7	3
3.	13	8	7	3
4.	17	6	7	2
5.	10	2	7	3
6.	13	6	7	4
7.	15	7	5	3
8.	14	7	6	2
9.	12	3	4	2
10.	16	9	7	4
11.	17	8	7	3
12.	12	4	4	2
13.	14	5	4	2
14.	14	6	7	4
15.	07	5	6	2

Contd. .... 24-A)

Group B

S.No.	Ist Order (Partial)	IInd Order (Quadruplet)	IIIrd Order (Complete)	IVth Order (Tria
16.	9	9	7	7
17.	10	8	6	5
18.	10	6	5	6
19.	10	6	4	4
20.	11	7	7	7
21.	11	10	5	7
22.	11	7	7	5
23.	12	11	6	6
24.	12	11	8	8
25.	13	7	7	6
26.	12	8	8	7
27.	14	10	6	7
28.	14	10	7	7
29.	11	7	5	6
30.	13	11	9	7

Contd........... A-34)

Group C.

S.No.	Ist Order (Triad)	IInd Order (Complete)	IIIrd Order (Partial)	IVth Order (Quadruplet)
31.	14	7	7	6
32.	14	6	5	6
33.	13	7	7	6
34.	13	5	5	5
35.	13	6	6	5
36.	13	7	8	6
37.	12	6	4	5
38.	12	6	7	6
39.	12	5	5	5
40.	12	6	5	5
41.	11	4	5	4
42.	11	6	5	6
43.	11	5	5	6
44.	11	4	4	4
45.	10	4	4	4

Contd............ A-34)

Group D.

S.No.	Ist Order (Quadruplet)	IInd Order (Partial)	IIIrd Order (Triad)	IVth order (Complete)
46.	14	3	5	11
47.	14	4	5	11
48.	11	3	4	8
49.	10	3	3	10
50.	6	3	3	10
51	6	2	3	6
52	10	3	4	6
53.	11	2	4	7
54	12	3	6	10
55.	12	3	4	7
56.	13	3	6	11
57.	13	3	3	9
58.	14	3	5	8
59.	14	3	5	10
60.	14	3	5	10

To test that the population means of K groups are equal, one may use as an alternative to the usual F-test, the statistic q defined as

$$(k, ne) \quad \frac{\bar{X}\,\text{max} - \bar{X}\,\text{min}}{\sqrt{\frac{\text{mean square of error}}{n}}}$$

$$\frac{T\,\text{max} - T\,\text{min.}}{\sqrt{n \times \text{mean square of error}}}$$

where $\bar{X}$ max and $\bar{X}$ min are respectively the largest and the smallest means out of K means. T max and T min are the largest and smallest group total.

ne df for the error m.s. It is assumed that all groups have n observations each under the null-hypothesis and under the assumption that the distribution of the measurements is approximately normal, the sampling distribution of the statistic q is that of the studentised range having parameters k = number of treatments and f degrees of freedom for Ms error.

The 95th and 99th percentile of the q-statistic are given in table B.4 of Winer's book, Statistical principles of experimental designs.

The q- statistic is particularly useful for testing which means differ from which others, after knowing that F-ratio is analysis of variance is significant.

This procedure is known as Newman Keuls method. According to this, necessary data have been taken from (Appendix

A-34 for first administration and table 11 of Chapter V, and table is prepared as below.

Table : Differences between total of 4 independent, Groups of 15 each.

Methods.	Complete pairs.	Triads.	Quadruplets.	Partial pairs.
Total sum of groups.	208	182	174	173
Complete pairs.	-	26*	34*	35*
Triads.	-	-	8	9
Quadruplets.	-	-	-	1

Here ne 56 and Ms error 4.693

q.95(k,56)	4	3	2
Q values at 95%	3.74	3.44	2.83
	31.38	28.86	23.74

Here T max - T min 35. This is greater than q.95 (4.56) 31.28 and so at 5% level, the mean of partial pairs differs significant by from that of complete pairs. Similarly the difference in totals for Q and complete pairs is 34, which is significant when compared with q.95 (3,56) 28.86. Also the difference in the totals of triad and complete pairs is .95(2,56) 23.74 But no other differ nces are significant. Hence the means of triad quadruplet and partial pairs may be regarded as differing significantly from the mean of complete pairs, but not differing significantly from each other.

A-36

To test the significance of difference between means of table 12, we use Newman Keul's procedure as explained in Appendix A-36. According to this procedure necessary data summarized below from tables 13 of Chapter V and Appendix A-34.

Table : - Differences between total of times
taken in four methods (based on data
from 60 subjects)

Method.	Complete	Quadruplet	Triads	Partial Pairs.
Total sum of Time for group 60 in each form.	519	473*	442*	339*
Complete	-	46*	77*	180*
Quadruplets	*	-	31*	134*
Triads.	*	-	-	103*
Truncated range	4	3	2	
.95(r,174)	(4,174)	(3,174)	C (2, 174)	
According to Winer's table, B-4.	3.63	3.31	2.77	
	15.28	13.94	11.66	

*Here all differences are significant. The complete pairs, ~~the minimum time and~~ it takes maximum time and partial pairs the minimum time, the triad takes less time, than quadruplets.